



Saskatchewan
Agriculture, Food
and Rural
Revitalization

ADF

**AGRICULTURE
DEVELOPMENT
FUND**

FINAL REPORT

20020258

**APPLIED RESEARCH AND INDUSTRY
DEVELOPMENT**

Funded by: The Agriculture Development Fund

April, 2004

Prepared by: Western Applied Research Committee



Western Applied Research Corporation

Annual Report 2003

Projects

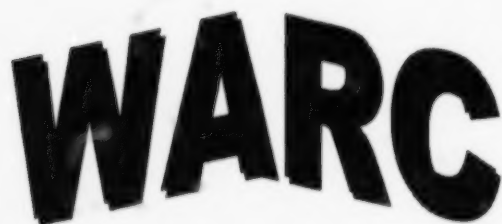
SAFRR Objectives:

1. Increased Value of Crop Production
 - a. Polymer coating with inoculants – project with Schumaker Seeds
 - i. Report complete and sent to Schumaker Seeds
 - b. Seeding depth of peas
 - i. Data complete and sent to Jody McConnell for report
 - c. Group 2 stacking
 - i. Completed 2nd year of 3rd project
 - ii. Interim report included.
 - d. Nozzle study
 - i. Completed 2nd year of project, interim report included.
 - e. Minor Use Program
 - i. Reports to be sent directly to ADF for the program
 - f. Phosphate fertilization for organic systems
 - i. Interim report included
 - g. Oat Cultivars for Organic Systems
 - i. Interim report included
 - h. Vinegar on Canada Thistle
 - i. Report included
 - i. Mechanical Weed control
 - i. Yields not obtained due to drought
2. Increase Livestock Production
 - a. Forage Oat/Barley variety trial
 - i. Data collected and submitted to Randy Pastl, Sask. Forage Council
 - b. Annual Forages Variety trial
 - i. Report attached, to be continued in 2004
 - c. Canola for forage
 - i. Data collected, samples submitted for forage analysis, report to be produced upon receipt of results
 - d. Brassica species for forage
 - i. Report attached, to be continued in 2004
 - e. Perennial Forage Trial
 - i. Data collected by Randy Pastl
 - f. Fertilization of perennial grasses
 - i. Data collected and initial report attached. Continued in 2004
3. Enhanced Environmental Stewardship
 - a. PAMI Hog Manure Demo
 - i. Interim report attached, to be expanded upon for 2004
 - b. SSCA Demo – seed placed urea with AgroTain
 - i. Report attached, to be expanded in 2004
 - c. Hybrid Poplar Demo

- i. Demonstration at field day was a success
 - ii. Trimmed trees in fall 2003 and will be planting cuttings in 2004
- d. Strawberry Crown Demo
 - i. Demonstration at field day was a success
 - ii. No harvest of crowns as wild life and drought dramatically affected yields

4. Ag People and families with better tools and resources to plan for their future:

- a. Field Days
 - i. Scott Field Day – July 9 at Scott Research Farm. Over 200 producers in attendance.
 - ii. Organic Field Day – July 10 at Scott Research Farm. Over 100 producers in attendance
 - iii. Weed Tour – July 11 at Kernon Farm at Saskatoon. Over 40 people in attendance. Included minor use projects.
 - iv. Lashburn Tour – July 22 at Lashburn Ag Ventures/AAFC site. Over 40 producers in attendance.
 - v. Loon Lake Tour – July 29 at AAFC site. Over 40 producers in attendance.
- b. Newsletter – produced in Feb 2004 (attached). Included reports on projects listed above and was dispersed to over 300 growers directly and to all rural service centres.
- c. Crop Update – Jan 29th at North Battleford. Over 60 producers in attendance
- d. Forage Update – Jan 28th at North Battleford. Over 40 producers in attendance
- e. Organic/PFP update – March 10th & 11th at Kenaston and North
- f. Research Update – March 19th at Wilkie. Over 50 producers in attendance



**Western Applied
Research
Corporation**

2003 Newsletter

WARC is a **producer based** organization that facilitates practical field level research and demonstration. It also ensures the transfer of technology from research to farm level, for the benefit of producers in NW Saskatchewan and the province. WARC is directed by a six member Board of Directors. Board members are local producers, representing both livestock and grain producers, from each of the six Agriculture Development and Diversification (ADD) districts in NW Saskatchewan.

WARC is affiliated with Agriculture and AgriFood Canada (AAFC) at Scott. The Scott Research Farm acts as the main site for research and demonstration as well as coordination of the projects. WARC is directly affiliated with Saskatchewan Agriculture and Rural Revitalization (SAFRR). The Regional Soils and Crops Agrologist is committed half time to AAFC to oversee the organization and implementation of WARC projects and the Board.

For more information about WARC, Board members, or project information, please contact: Sherrilyn Phelps, Soils & Crops Agrologist at 446-7475 or Scott Research Farm at 247-2011.



**Saskatchewan
Agriculture, Food
and Rural
Revitalization**



**Agriculture and
Agri-Food Canada
Research
Branch**

**Agriculture et
Agroalimentaire Canada
Direction générale
de la recherche**

Canada

Annual Forages

Wally Vanin, Rangeland & Forage Agrologist, SAFRR
Sherrilyn Phelps, Soils & Crops Agrologist, SAFRR

In recent years beef producers have increasingly utilized annual forages for winter feed production, summer grazing and swath grazing. In 2003, annual forages were evaluated for yield and quality at three locations in North West Saskatchewan. For greenfeed and silage production, yield and quality were optimized by planting cereals in early May. For swath grazing, planting was delayed until June 10 to June 15 to provide for delayed maturity, with swathing occurring after August 20th. To simulate both greenfeed/silage and swath grazing options, two seeding dates of May 15 and June 10 were used.

When cool season crops such as oats, barley, and triticale are planted in May, they utilize spring and early summer moisture to produce growth in June and July. Warm season crop such as Foxtail Millet, Proso Millet, and Sorghum-Sudan Grass planted in June, utilize mid to late summer moisture to produce growth during July and August. Corn is also a warm season crop. When planted in May, it produces most of its growth in July and August. In the black soil zone of Saskatchewan the late maturing warm season crops have potential to utilize late summer moisture and produce superior yields compared to late seeded cool season cereals. In Eastern Saskatchewan it has been found that late maturing Golden German Millet produced superior yields for swath grazing compared to oats and barley planted in June. In the dark brown and brown soil zones, early seeded cool season crops such as oats and barley produce superior yields because rainfall in late July and August is generally lower. However, early maturing warm season crops such as Crown and Siberian Millet may have potential, as they complete most of their growth by the end of July.

Yield results from 2003 show no significant differences between the cool season crops and the millet crop (Table 1). Corn produced the highest yield at all locations with no difference between the intensively managed (IM) corn and the corn that did not receive extra nitrogen. The Sorghum-Sudan Grass produced the lowest yield due to poor establishment at all sites. There was no effect of seeding date because moisture was the limiting factor.

Table 1. Dry matter yields from annual forage trials at Loon Lake and Scott in 2003.

		Loon Lake			Scott			Overall Average
		May 19	June 11	Average	May 16	June 11	Average	
Crop	Variety	Dry matter yield (tons/acre)						
Oat	AC Pinnacle	3.00 b	2.24 b	2.62 c	2.66 b	3.17 c	2.91 c	2.77 b
Oat	CDC Bell	2.69 b	1.88 bc	2.29 c	2.49 b	2.99 c	2.74 c	2.51 b
Barley	Rosser	2.63 b	2.27 b	2.45 c	2.14 bc	2.17 cd	2.16 c	2.30 b
Barley	Ranger	2.38 b	2.29 b	2.34 c	2.66 b	2.94 c	2.80 c	2.57 b
Triticale	Ultima	2.51 b	2.60 b	2.55 c	2.47 bc	2.75 c	2.61 c	2.58 b
Millet	Crown	2.01 bc	2.52 b	2.27 c	3.15 b	2.83 c	2.99 c	2.63 b
Millet	Golden German	1.86 bc	2.11 b	1.99 c	2.68 b	2.38 cd	2.53 c	2.26 b
Sorghum	Mega green	0.95 c	1.27 bc	1.11 d	1.38 c	0.84 d	1.11 d	1.11 c
Corn	LL 39T71	6.04 a	5.96 a	6.00 a	4.35 a	5.67 b	5.01 b	5.50 a
Corn IM	LL 39T71	5.52 a	4.52 a	5.02 b	4.96 a	7.44 a	6.20 a	5.61 a
	LSD ($p < 0.05$)	1.45	0.76	0.81	1.09	1.66	1.00	0.64
	CV	33.8	18.9	28.3	26.1	34.5	32.2	30.51

Numbers with same letter following are not significantly different.

AC Pinnacle oats outyielded CDC Bell Oats at all locations due to its earlier maturity. Crown Millet, an early maturing forage type of Proso Millet, out yielded Golden German Foxtail Millet at all locations. Crown Millet exhibited greater drought tolerance and remained green during the prolonged dry weather in July and August. The Golden German Millet began to senesce during the hot dry weather and stopped growing while in the vegetative stage.

Rainfall in the North West Region was below average during the 2003 growing season. Rainfall in late August and September came too late for all crops except corn. Crop heat units (CHU) were above average in July and August which favored the warm season cereals. In 2003 Unity and North Battleford had 2047 CHU, while Meadow Lake had 1887 CHU. The heat units required for corn is 2100 for the earliest varieties, so in 2003 there was good cob formation and filling.

For the North West Region, cool season crops such as oats, barley and spring triticale planted in early spring remain the best option for producing greenfeed or silage. For swath grazing or late seeding conditions, producers should consider both the cool season crops and the warm season crops. Establishment problems and limited experience with Sorghum Sudan grass suggests this crop is more risky for NW Saskatchewan. The late maturing Golden German Foxtail Millet has the potential to out yield late sown cereal crops if rainfall is received in July and August. The trials in 2003 indicated that Golden German Millet can produce yields equal to late seeded cereals with reduced rainfall in July and August. Early maturing Crown Millet does not have high yield potential because it completes its growth by early August, whereas the Golden German Millet continues to grow until early September.

With corn yields in excess of 5 tons/acre dry matter, there is potential for limited acres of corn for silage and fall grazing in years with above average heat units. The 20 year average crop heat units for Scott is 2074, which is close to the 2100 heat units required for the earliest varieties of silage corn. For best results, producers should plant corn on their best land, plant in May, provide excellent weed control and provide high fertility. In 2004 we will continue to evaluate the performance of annual forage crops. For more information on growing annual forage crop please contact Wally at the North Battleford Rural Service Centre at (306) 446-7650.

Turnips

Sherrilyn Phelps, Soils & Crops Agrologist, SAFRR

Brassica species have been long known for their use as forage crops in much of the world. Turnips, rutabagas, rape, kale and Swedes are examples of commonly used forage brassicas. The short-season root brassicas such as rutabagas and turnips, provide roots, stems, and leaf growth for grazing. These crops have good tolerance to frost. Top growth generally will survive temperatures between 15-20 degrees F, while bulbs will be about 5 degrees hardier. Protein levels from production in the United States range from 17-24% for tops and 12-15% for roots. In 2002 turnips were grown at Scott, SK and protein levels were 20% for tops and 17% for bottoms. High digestibility with total digestible nutrients (TDN) of 75-90% and relative feed value (RFV) of 350-400% also make these crops appealing for livestock producers. Nutritive components, coupled with adaptability of other brassica species such as canola and mustard, suggest that turnip species as a forage crop may have a fit in the forage and livestock industry in Western Canada. The objectives of this research were to establish a growth curve for turnips (to identify optimum time for grazing) and to obtain yields of forage produced.

In 2003 trials were conducted at Scott, Loon Lake, and Lashburn. The conventional turnip variety (Marko) was compared to a hybrid variety (Typhon). The hybrid variety is based on a cross between Chinese cabbage and turnip. Also included was a canola hybrid LL 2663. Establishment of the crops, forage dry matter production, uniformity, and regrowth after cutting, were evaluated for each variety. Dry matter accumulation was very similar between the brassica species when total biomass was analyzed. Canola (LL2663) produced the greatest total biomass at 4177 kg/ha, followed by the turnips at 3920 kg/ha for Marko and 3270 kg/ha for Typhon. Although Marko produced greater total biomass than Typhon,

Typhon produced more above ground material (Figure 1).

For turnips, the optimum time for grazing is suggested to be at maximum production of above ground biomass and as early as possible, to allow maximum regrowth. After this time there is little gain in above ground biomass, and the regrowth period would be shortened. The point at which this occurred in 2003 at Scott was between 500 and 600 GDD which corresponded to between July 14 and 21st. However, previous recommendations for grazing turnips were 60 days after seeding which corresponded to July 28. Sixty days after seeding the second half of the plots were harvested for total above ground dry matter, then left to allow regrowth to occur. The above ground material harvested at this time at Lashburn, Loon Lake, and Scott, averaged: 3497 kg/ha for canola, 2904 kg/ha for Typhon turnips, and 2350 kg/ha for Marko turnips. Regrowth of these plots were prohibited by insect infestations and dry conditions.

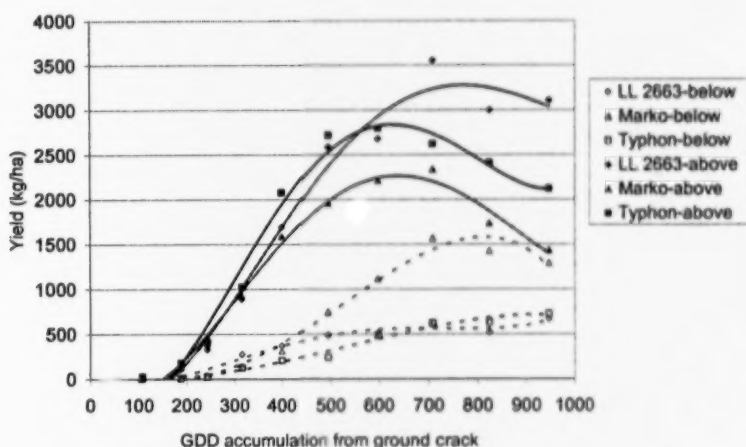


Figure 1. Growth curve for above and below ground biomass based on growing degree day (GDD) accumulation starting at ground crack on June 4, 2003. Forth order polynomial trendlines were used to depict the growth curves. Sample dates correspond to June 4, 16, 24, 30, July 7, 14, 21, 28, August 4, 11, and 18th.

In conclusion, turnips are an appealing alternative for grazing in terms of the amount of forage produced, their digestibility, protein, and feed values. The growth curve is very similar to that of canola, which is well adapted to Western Canada. Yield potential is still unknown. Under drought conditions yields averaged 2350 to 2904 kg/ha for top growth. We have no yield information for turnip grown under good moisture conditions. From the growth curve analysis it was found that Marko turnip had another 1113 kg/ha of biomass in the tuber. Adding this amount to the above ground portion brings up the total biomass to 3363 kg/ha, which is very close to that of canola (3497 kg/ha). From the growth curve it was found that between 500 and 600 GDD could be the appropriate time for the first graze. Grazing prior to this stage would reduce yields dramatically. There would be no gains in dry matter and less time for regrowth, if grazed after this stage. Unfortunately, in 2003, there was very little regrowth on the plots due to flea beetles, grasshoppers, and very dry conditions.

Further research on turnips is needed under better moisture conditions. A repeat of this experiment over a number of locations and environmental conditions is warranted to better evaluate growth and suitability in Western Canada. Research is also needed on pest control, optimum cutting times to maximize total biomass production and regrowth potential, and intercropping possibilities.

Hog Manure Applied to Forage

Stewart Brandt, AAFC Scott Research Farm

A demonstration of liquid hog manure applied on perennial forage was initiated in 2003 at Scott on an old stand of forage that was primarily brome and crested wheat grass with some alfalfa and other grasses. The stand is over 40 years old and suffers from very low available P [less than 5 kg/ha available P_2O_5 in the upper 30 cm]. Three rates of hog manure (3000, 6000 and 9000 gallons per acre) were applied in either early spring (E) or late spring (L). Granular fertilizer was also applied at a rate of 70 kg/ha N as ammonium nitrate plus 35 lb/ac of P_2O_5 as triple super phosphate.

The growing season started with fair soil moisture, and early forage growth was good. Drought later in the year restricted final yield. Early application of hog manure resulted in good responses that increased with the rate of applied manure (Figure 1). All rates provided higher yield than the check (where no fertilizer or manure was applied) and equal or greater yield than the granular fertilizer. The coulters used to inject manure caused some damage to the forage, but it recovered quickly except an area very close to that cut by the coulters. This area, 2-5 cm wide, showed very little green growth.

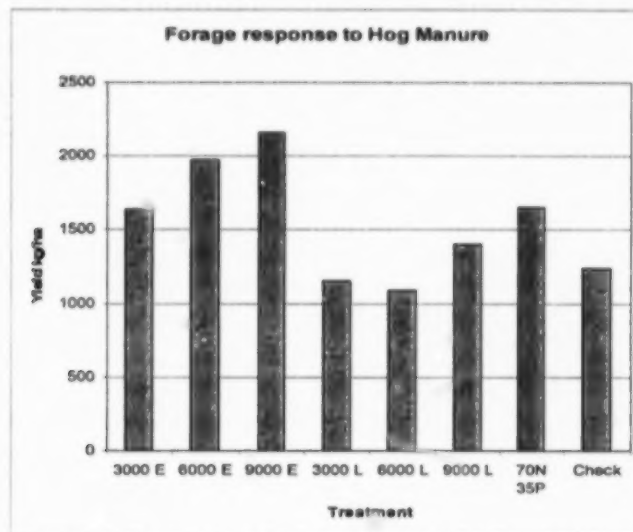


Figure 1. Response of forage stand to injection of liquid hog manure (kg/ha).

Later application of hog manure had lower response than early applications and caused greater damage to the forage, resulting in strips 15-20 cm wide with little green growth. Damage increased with rate of hog manure. Only the highest rate of hog manure, when applied late, showed yield improvement over the check. Rejuvenation of old forage stands using liquid hog manure early in the season shows some promise. Further research on fall applications and multiple applications will be started in 2004.

Urea Treatments Affect Safe Rates of Seed Placed N

Stewart Brandt, AAFC Scott Research Farm

Seed placed fertilizer nutrients can damage seedlings resulting in poor crop establishment. Damage results from either: a salt effect that restricts water uptake with nitrate based fertilizers, or an ammonium toxicity that damages enzymes needed for germination and early growth with urea type fertilizers. Several strategies have been developed to reduce seedling damage from fertilizers. Restricting the amount that is seed placed is effective but usually does not allow for application of adequate N. Placing fertilizer at a safe distance, such as side-banding, can overcome the rate restriction but increases soil disturbance and costs. Placement before or after seeding usually has a good margin of safety, but requires added operations and costs.

Agrotain, a commercial treatment applied to urea granules, affects how rapidly urea is converted to ammonium by restricting the activity of the urease enzyme. Research suggests that the safe rate of N can be increased by 50% where Agrotain is used. To demonstrate the effectiveness of Agrotain, a project was initiated by SSCA through Western Applied Research Corporation at the Scott Research Farm in 2003. Treatments included urea, Agrotain treated urea, and side banded urea. Application rates ranged from 0 to 6X the recommended safe rate for wheat of 25 lbs/acre (22 kg/ha) for knife opener with 9 inch spacing in medium textured soil. Recommended safe rate was obtained from SAFRR Farm Facts:

Guidelines for safe rates of fertilizer applied with the seed.

To evaluate crop establishment plant counts were taken at 14, 20, and 28 days after seeding [DAS]. Results in Figure 1 show plant densities declined as N rate increased with the seed placed urea and Agrotain treated urea. However, the side-banded urea was unaffected in terms of plant density. The Agrotain treated urea did not cause as large a reduction in plant density as untreated seed placed urea. Percent soil surface covered by green plant material at 26 and 32 DAS was analyzed through use of digital photos and computer software (data not shown) and supports the plant emergence results.

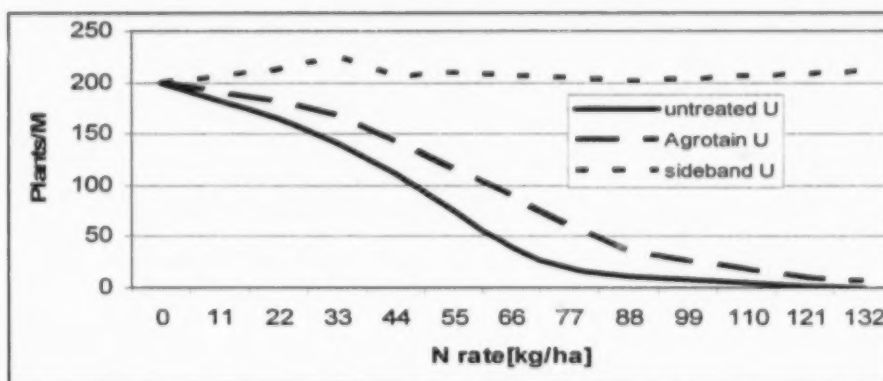


Figure 1. Wheat plant densities with urea N fertilizer either untreated and seed placed, Agrotain treated and seed placed, or untreated and side-banded at rates of 0 to 132 kg/ha at Scott in 2003.

Yield data shows no response to N fertilizer (data not shown). This reflects the lack of moisture and late seeding of the crop, indicating the soil met all crop N requirements in the absence of fertilizer N. Where emergence was reduced by seed placed untreated or Agrotain treated urea, yield declined as N rate increased. Overall, side-banding of urea was the safest option. However, untreated and Agrotain treated urea resulted in yields that were similar to sidebanded urea at 1 (22 kg/ha) and 1.5 X (33 kg/ha), respectively. This confirms the recommendations for Agrotain: that safe rates of seed placed urea can be increased by about 50% if Agrotain is used.

Oat Cultivars For Organic Systems

Stewart Brandt, AAFC Scott Research Farm

Oat cultivars were evaluated under organic and conventional production at Scott in 2002 and 2003. The objective was to evaluate whether newer cultivars were more dependent upon inputs of pesticides and fertilizers than older ones, and consequently, less suited to organic production. If this is the case, a separate plant breeding effort would be required to develop varieties suited to organic production. If it has not, it suggests that current plant breeding efforts may be suited to both production systems.

The trial was set up as a split plot with conventional and organic inputs as main plots, and cultivars as sub plots. Trials were conducted on summerfallow. The conventional treatments received 44 kg/ha of P₂O₅ and 90 kg/ha of N fertilizers, and were treated with Buctril M for broadleaf weed control. Organic treatments did not receive any fertilizer or herbicide. Seeding was done June 20, 2002 and May 28, 2003. In both years, insecticides were applied to both organic and conventional inputs to control grasshoppers.

Extreme drought occurred in 2002, but yields were surprisingly good because the crop was seeded very late and was able to take advantage of late season precipitation. Drought also prevailed in 2003 and the crop was able to take advantage of late season moisture to produce high yield. Weed pressure was very low both years and had little if any impact on yield of any treatments. Grasshoppers did cause damage to all cultivars, but damage was minimized with insecticides.

Yields are presented in Table 1. When averaged over all varieties the conventional input treatments resulted in yields that were 7% higher than with organic inputs. The three current cultivars (Calibre, CDC Dancer, and AC Morgan) were 8% higher yielding than the older cultivars (Victory, Garry, and Harmon). These yield differences were smaller than what would be predicted based on yield performance data from other trials. This may be related to late seeding which tends to reduce yield response by oat. However yields were quite high considering the moisture conditions of the 2 years.

The most interesting result involved CDC Dancer, which yielded more with organic than conventional inputs in both years. This was the highest yielding cultivar overall. This suggests that current cultivars can be high yielding in both organic and high input systems. It also suggests that current oat breeding programs may develop cultivars suited to organic production, but that extra effort to evaluate candidate cultivars is needed to identify which are most suitable. These results need to be viewed cautiously, since they represent only 2 years of data at 1 location, and results have not been completely analyzed to date.

Table 1. Performance of oat cultivars with organic and conventional inputs at Scott (2002 and 2003).

	Victory	Garry	Harmon	Calibre	CDC Dancer	AC Morgan
2002 yield [kg/ha]						
Organic	1580	1850	1920	1880	2210	1690
Conventional	1880	2020	2330	2050	2170	2130
O/C	0.84	0.92	0.82	0.92	1.02	0.8
2003 yield [kg/ha]						
Organic	3010	2920	2560	2920	3590	3570
Conventional	3010	3520	2940	3150	3330	3330
O/C	1.00	0.83	0.87	0.93	1.08	1.07
OVERALL MEAN	2370	2579	2436	2500	2823	2682

Phosphate Replacement Strategies for Organic Growers

Stewart Brandt, AAFC Scott Research Farm

A field experiment to evaluate the effectiveness of compost as a P replacement strategy for organic systems was initiated in 2002. Composted cattle manure was applied at 3.6, 7.2, and 14.4 tonnes per ha to supply 20, 40, or 80 kg/ha of P, respectively. A combined treatment involving compost and rock phosphate was included to evaluate whether compost might aid in release of P from rock phosphate. Checks included no P and a triple super phosphate treatment. Where applications were made, they were incorporated with tillage. Plots were sown to AC Elsa wheat in 2002 and to Espace pea in 2003. Biomass samples were taken at 4 weeks after emergence and at crop maturity, and used for determination of biomass dry matter yield and N and P content. Grain yield was determined in 2003, but not 2002 because yield was so low under drought conditions.

The soil at this site has a long history of hay production with very little fertilizer added over the past 40+ years. Consequently available P was very low, with only about 2 kg/ha of available P_2O_5 present in the surface 30 cm of soil.

Treatments had no significant impact under the very dry conditions of 2002, but triple super phosphate did increase biomass yield at 4 weeks after emergence and seed yield in 2003. Dry conditions undoubtedly restricted yield responses in both years, but broadcast and incorporation as a means of supplying P has been shown to be rather inefficient for applying P fertilizers compared with band placement. This could apply to other P sources, since much of the applied P could be unavailable to the crop. The fact that there was a detectible response to triple super phosphate in 2003, suggests that other methods for applying P were not as effective to date. This experiment needs to be continued for several more years as it may take some time for the organic sources to be effective. The questions that need to be addressed relate to whether a response to compost P will occur, and if so, how large it may be, and how long it will take before it is evident.

Table 1. Biomass and yield response to P treatments at Scott, 2002 and 2003.

	Biomass at 4 wk [kg/ha]		Biomass at mature [kg/ha]		Grain yield [kg/ha]
	2002	2003	2002	2003	2003
No P	249	422	546	6520	768
20 P as compost annually	182	464	510	7020	884
40 P as compost annually	213	520	674	6990	875
40 P as compost one time	189	424	528	6550	789
80 P as compost one time	206	419	610	6780	888
40 P compost/40 P rock phosphate	200	411	484	6060	794
20 P as triple super phosphate [0-45-0], annually	253	603	683	7200	943
LSD $P=0.05$	ns	ns	ns	121	138

Optimizing Crop Yield Through Timeliness of Weed Removal With Low Drift Nozzles

Eric N. Johnson and T.M. Wolf, AAFC Scott & Saskatoon

The time of weed removal is known to be of key importance in protecting high cereal, pulse, and oilseed yields in Saskatchewan. Implementing timely weed removal can be hampered by unfavourable weather conditions such as high winds, which cause significant delays in the application of herbicides. Low-drift sprays can be applied in a timely fashion under windier conditions, but there have been concerns with product effectiveness, particularly on competitive grassy weeds. It is unknown whether the advantage of timely weed removal is offset by the disadvantage of reduced product efficacy. The objective of this project is to develop practical information on the relative importance of timely weed removal vs. the use of coarser sprays. It is hypothesized that the lower efficacy with a coarse spray is more than compensated by the advantage of timelier removal that is facilitated by this technology.

Barley (*cv.* AC Metcalfe), Polish canola (*cv.* AC Sunbeam) and flax (*cv.* Vimy) were seeded on May 15, 2003. Wild oats and wild mustard were seeded at a uniform density between the crop rows at the same time as the crop was seeded. Each crop was treated with a registered Group 1 gramincide tank-mixed with an appropriate broadleaf herbicide and applied at a carrier volume of 110 l ha⁻¹ (Table 1). Data collected included crop density and fresh weight, weed density and fresh weight (by species), and crop yield.

Table 1: Crops, herbicide, rates, nozzle type and timing of application used in study. Scott, 2002.

Crops	Herbicide/ Rate(g ai ha ⁻¹)	Nozzles	VMD*	Timing
Barley <i>Good competitor</i>	Achieve / 200	TeeJet XR8001	150	7 DAE*
	Buctril M / 560	Air Mix 11001	250	17 DAE
		TurboDrop XL 11001/TT11002	400	
Canola <i>Medium Competitor</i>	Select / 47	TeeJet XR8001	150	7 DAE
	Muster / 22	Air Mix 11001	250	17 DAE
		TurboDrop XL 11001/TT11002	400	
Flax <i>Poor competitor</i>	Select / 47	TeeJet XR8001	150	7 DAE
	Buctril M / 560	Air Mix 11001	250	17 DAE
		TurboDrop XL 11001/TT11002	400	

*DAE = Days after emergence; VMD= Volume Median Diameter (150 = fine, 250 = medium, 450 = coarse droplet size)

The barley and canola established well, with mean plant densities of 187 and 121 plants m⁻² respectively. The flax did not establish quite as well as the mean density was 72 plants m⁻², which is well below the desired plant population of 300 to 400 plants m⁻².

Effect on weed control

There was a significant crop by nozzle type interaction for wild oat control (Figure 1). In the more competitive stands of barley and canola, each nozzle type caused similar reductions in wild oat biomass. However, the coarse spray quality produced by the Turbodrop XL nozzle was not as efficacious as the other nozzles in the non-competitive flax stand. Therefore, the reduction in efficacy observed with coarse sprays may be less of an issue in competitive crop stands. When time of application is considered, the early spraying (7 DAE) resulted in a lower wild oat fresh weight than the later application (14 DAE). This was consistent across the three crops and four nozzle types.

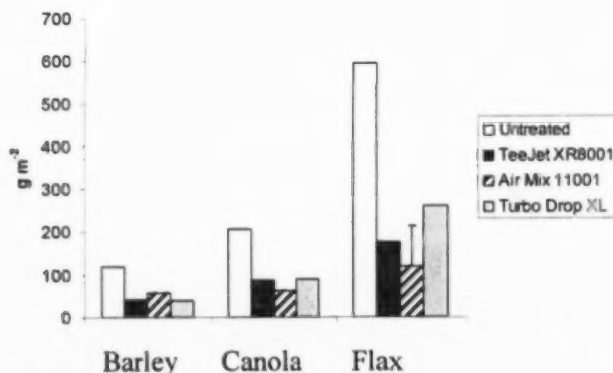


Figure 1: Interaction of crop and nozzle type on wild oat fresh weight. Bar represents the $LSD_{0.05}$ for the crop X nozzle type interaction. Scott, 2003.

All the broadleaf weed species responded similarly to herbicide applications. Results for wild mustard, the predominant species, show crop had a significant effect on wild mustard fresh weight with values of 21, 207, and 92 g m⁻² for barley, canola, and flax, respectively. There was no significant effect of nozzle type on wild mustard biomass (data not shown). Unlike the wild oats, there was no timing effect indicating that control of wild mustard was similar for both early and late applications of herbicide.

Effect on crop yield

For crop yield, there was a significant crop by nozzle type interaction due to differences in crop response to herbicide application. All nozzle types resulted in a yield increase in the barley and flax; however, there was not a detectable yield increase with any of the nozzles in canola (Figure 2). This is likely due to the poorer control of wild mustard in canola compared to the barley and flax.

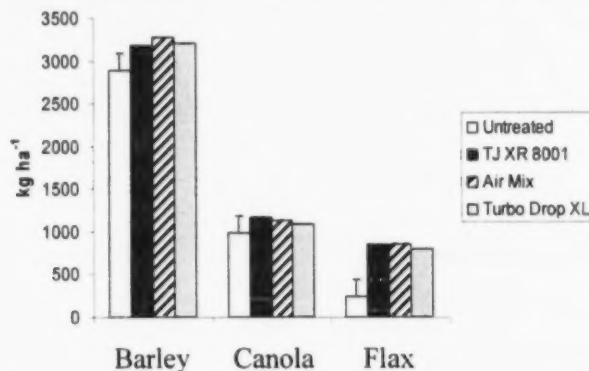


Figure 2: Interaction of nozzle type with yield of barley, canola, and flax (kg ha⁻¹). Bar represents the $LSD_{0.05}$ for the crop X nozzle type interaction. Scott, 2003.

The other significant interaction for crop yield was a nozzle by timing interaction (Figure 3). Crop yields declined with the medium and coarse spray qualities when applied late, but yields were not significantly different from the fine spray quality when applied early. Therefore, crop yields can be maintained with coarse sprays provided that they are applied in a timely manner.

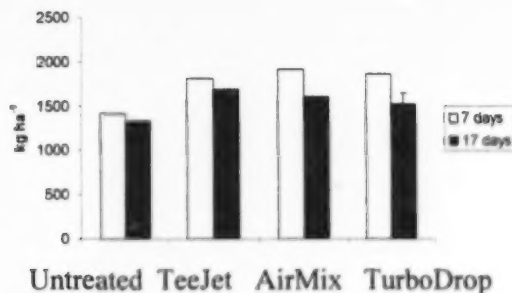


Figure 3: Interaction of nozzle type with timing of herbicide application on crop yield (mean of barley, canola, and flax). Bar represents the $LSD_{0.05}$ for the nozzle type X timing interaction. Scott, 2003.

The first year of this study indicates that crop yield will not be compromised by a coarse spray quality provided that a competitive crop stand is present and application timing is not delayed. Timely application is more likely to occur with low drift (coarse spray quality) nozzles since herbicides can be applied in a wider range of environmental conditions. The experiment will be repeated in the future. The data suggests that there is opportunity to explore interactions of low-drift nozzle technology with other cultural and integrated weed management strategies. Evaluation of reduced rates combined with nozzle technology and integrated practices appear to be the next logical step.

Repeated Applications of Residual Herbicides

Eric Johnson, AAFC Scott Research Farm

When it comes to repeated applications of residual herbicides, there are three issues of concern:

- 1. Predisposition to injury** – an increase in crop sensitivity to herbicides the year following the application of a residual herbicide. An example of predisposition to Group 2 injury is: Odyssey applied to field pea in Year 1, Everest applied post-emergence to the spring wheat in Year 2. Does the initial application of the Odyssey predispose the crop to higher levels of injury from the Everest application compared to a situation where no residual Group 2 herbicide was applied in year 1?
- 2. Accumulative effects** – this involves the multiple application of the same residual herbicide over time. In the case of an accumulative effect, product A is being applied to ground that has some level of product A already present in the soil from a previous year. Do these residues accumulate over time? This is basically a herbicide rate issue and is typically evaluated by herbicide companies in the registration process.
- 3. Stacking effects** – this involves the repeated application of different residual products in subsequent years. In such a case product B may be applied on top of a residue of product A or perhaps another product C may be present. What is the combined effect of the two or more residues on sensitive rotational crops? The overall effect of the residues may be additive, or synergistic. If the effects of the residues are additive there is no interaction and effects on plants are independent and predictable. In other words, if there is 1 gram per acre of herbicide A present in the soil and 1 gram per acre of herbicide B present in the soil, then the overall effect would be similar to 2 grams of either herbicide A and B in the soil. If the effect of the residues is synergistic, then the resulting injury to the sensitive crop is greater than the sum activity of its individual components. This may result in more limited follow-crop options to the grower.

Research has been initiated at 8 locations in Alberta and Saskatchewan to evaluate the repeated applications of Group 2 herbicides. The sites represent a number of different soil types with a range of organic matter content, pH, and texture. There were two experiments initiated in 2002 (Table 1).

Table 1. Outline of experiments and herbicide applications initiated in 2002.

Experiment 1				
2002	Herbicide (main plot)	2003	Herbicide (subplot)	2004
Wheat	Non group 2* Assert Refine Extra Sundance Spectrum Frontline Everest	Field pea	Basagran* Sencor * Odyssey	Canola
Experiment 2				
2002	Herbicide (main plot)	2003	Herbicide (subplot)	
Pea	Non group 2* Odyssey	Wheat	Non group 2* Assert Sundance Everest Frontline	Canola

* non group 2 checks

Since only the second year has been completed, the results can only address the issue of predisposition to herbicide injury. Crops seeded on these plots in 2004 will give an indication of the potential "stacking" effects.

In experiment 1, there was very little indication that the application of Group 2 herbicides applied in year 1 predisposed the following field pea crop to Odyssey injury. In experiment 2, Odyssey applied to the field peas appeared to increase the sensitivity of the wheat crop to post-emergence applications of Everest, Sundance or Frontline on the low organic matter, acid soils at Scott. Scott was the only site (out of eight sites) where the repeated application of Group 2 herbicides resulted in a yield reduction compared to treatments where a Group 2 herbicide was applied in one of the two years. This experiment will be repeated at some locations to get a better understanding of the frequency that a yield reduction may occur.

Until more is known about the repeated application of Group 2 herbicides, it is important that producers follow label directions. No matter the outcome of the research, it is still prudent for producers to rotate herbicide groups in order to manage herbicide resistant weed populations.

Vinegar for pre-seed and post-emergence control of broadleaf weeds in spring wheat

E.N. Johnson, T.M. Wolf, and B.C. Caldwell, AAFC

Research conducted by the USDA indicated that vinegar with acetic acid concentrations of 10 to 20% provided good control of some annual and perennial weed species. It was hypothesized that vinegar may be a potential non-selective herbicide option for pre-seed or pre-emergence weed control in organic crops. Initial greenhouse studies at the Saskatoon Research Center indicated that grass weeds were more tolerant to vinegar than broadleaf weeds. Thus, a field study was conducted at the Scott Research Farm in 2003 to investigate the efficacy of a pre-seed application of vinegar as well as the potential for selective broadleaf weed control in spring wheat.

The study area contained a high natural inherent population of winter annual weeds, in particular shepherds purse. A vinegar formulation of 10% acetic acid (commercial vinegar is 5% acetic acid) was applied three days prior to seeding spring wheat at rates in Figure 1. An untreated check was included

and glyphosate at 0.5 liter/acre was included as a commercial standard check. The weeds were in the cotyledon or rosette stage with the majority being less than 1 cm in diameter. Spring wheat (cv. Eaton) was then seeded at a rate of 90 kg ha⁻¹ in 22 cm rows on May 13, 2003. Wild mustard and cow cockle were seeded between the crop rows at a uniform density. The same vinegar treatments were then sprayed in the wheat crop when the wheat was in the 1-2 leaf stage and the broadleaf weeds were in the cotyledon to 1-leaf stage. The commercial standard check received a Buctril-M application at a rate of 0.4 litre/acre. Visual control ratings of the pre-seed application were done 3, 6 and 10 DAT while ratings of the post-emergence application were done 3, 6, 19, and 28 DAT. Weed counts, weed biomass, and crop yield data was also collected.

Pre-seed

- Pre-seed application of 10% acetic acid vinegar resulted in over 80% control of shepherd's purse at application volumes of 1600 L ha⁻¹ or higher. Injury symptoms appeared quickly (within 1 to 3 days).

Post-emergence

- Vinegar rates higher than 400 L ha⁻¹ caused initial wheat injury but recovery occurred with little visible injury 28 DAT. In-crop application volumes of greater than 800 L ha⁻¹ resulted in greater than 80% control of wild mustard and cow cockle; however, some regrowth was evident at this rate.
- Weed biomass was reduced by 60% at 800 L ha⁻¹, and 90% at 1600 L ha⁻¹ and greater (Fig. 1).
- Highest wheat yields were attained at 800 L ha⁻¹. However, an application volume of 400 L ha⁻¹ resulted in a significant yield response that was comparable to the commercial standard (Fig. 2). Initial injury to the weeds from the 400 L ha⁻¹ rate may have provided a competitive advantage to the spring wheat, even though long-term weed control at this volume would be considered unsatisfactory.
- Dandelions present in the study were not uniform in all replicates to rate. However, application volumes of 2400 L ha⁻¹ were unable to control dandelion. Significant injury occurred on the outer leaves. However, complete recovery occurred within two to three weeks.

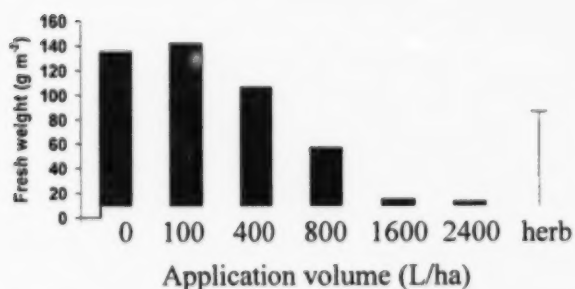


Figure 1. Effect of vinegar (10% acetic acid) application on broadleaf weed fresh weight. Error bar represents the LSD ($P < 0.05$). Scott 2003.

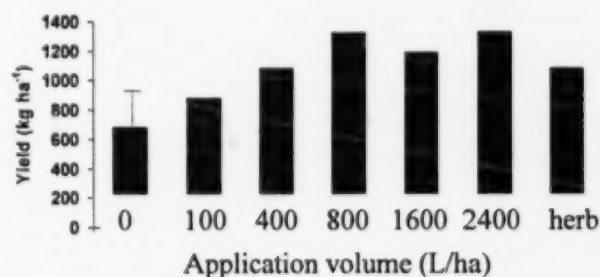


Figure 2. Effect of vinegar (10% acetic acid) application on yield of spring wheat. Error bar represents the LSD ($P < 0.05$). Scott 2003.

Application volumes greater than or equal to 1600 L ha⁻¹ were required to provide weed control comparable to the commercial standards; however, wheat yields were maximized and similar to the commercial standards at application volumes of 400-800 L ha⁻¹. The cost effectiveness of vinegar needs further evaluation since pesticides in Western Canada are not commonly applied at these application volumes. The cost of the product used in this study was \$160.00 for 200 litres (80 cents/litre).

When it comes to repeated applications of residual herbicides, there are three issues of concern:

- 1) Predisposition to injury – an increase in crop sensitivity to herbicides the year following the application of a residual herbicide. An example of predisposition to Group 2 injury is: Odyssey applied to field pea in Year 1, Everest applied post-emergence to the spring wheat in Year 2. Does the initial application of the Odyssey predispose the crop to higher levels of injury from the Everest application compared to a situation where no residual Group 2 herbicide was applied in year 1?
- 2) Accumulative effects – this involves the multiple application of the same residual herbicide over time. In the case of an accumulative effect, product A is being applied to ground that has some level of product A already present in the soil from a previous year. Do these residues accumulate over time? This is basically a herbicide rate issue and is typically evaluated by herbicide companies in the registration process.
- 3) Stacking effects – this involves the repeated application of different residual products in subsequent years. In such a case product B may be applied on top of a residue of product A or perhaps another product C may be present. What is the combined effect of the two or more residues on sensitive rotational crops? The overall effect of the residues may be additive, or synergistic. If the effects of the residues are additive there is no interaction and effects on plants are independent and predictable. In other words, if there is 1 gram per acre of herbicide A present in the soil and 1 gram per acre of herbicide B present in the soil, then the overall effect would be similar to 2 grams of either herbicide A and B in the soil. If the effect of the residues is synergistic, then the resulting injury to the sensitive crop is greater than the sum activity of its individual components. This may result in more limited follow-crop options to the grower.

Research has been initiated at 8 locations in Alberta and Saskatchewan to evaluate the repeated applications of Group 2 herbicides. The sites represent a number of different soil types with a range of organic matter content, pH, and texture (Table 1).

There are two experiments involving 2 crop sequences. The project was initiated in 2002. The first experiment involves a wheat – field pea – barley or wheat – canola sequence. The second experiment involves a field pea – wheat – canola sequence. In 2003, the second phase of the crop sequence (field pea in experiment 1, wheat in experiment 2) was completed.

In experiment 1, the wheat phase received the following herbicide applications in 2002: a Non-Group 2 check, Assert, Refine Extra, Sundance, Spectrum, Frontline, or Everest. In 2003, the field pea crop received either a Basagran check, Sencor check, or Odyssey check.

In experiment 2, the field pea phase received either an application of a non-Group 2 check or Odyssey in 2002. In 2003, the wheat phase received an application of a non-Group 2 check, Assert, Sundance, Everest, or Frontline.

Since we have only completed the second year of the crop sequence, the results can only address the issue of predisposition to herbicide injury. In 2004, we should get an indication of the potential “stacking” effects if any.

In experiment 1, there was very little indication that the application of any of the Group 2 herbicides applied in year 1 predisposed the following field pea crop to Odyssey injury. In experiment 2, Odyssey applied to the field peas appeared to increase the sensitivity of the wheat crop to post-

emergence applications of Everest, Sundance or Frontline on the low organic matter, acid soils at Scott. Scott was the only site (out of eight sites) where the repeated application of Group 2 herbicides resulted in a yield reduction compared to treatments where a Group 2 herbicide was applied in one of the two years. This experiment will be repeated at some locations to get a better understanding of the frequency that a yield reduction may occur.

Until more is known about the repeated application of Group 2 herbicides, it is important that producers follow label directions. No matter the outcome of the research, it is still prudent for producers to rotate herbicide groups in order to manage herbicide resistant weed populations.

Table 1: Soil characterization of sites for repeated Group 2 herbicide application studies.

Site	Soil Zone	S.O.M.	pH	Texture
Scott	Dk. Brown	3.0	5.9	Loam
Lethbridge	Dk. Brown	3.6	7.8	Clay loam
Saskatoon	Dk. Brown	3.8	7.4	Clay
Vanscoy	Dk. Brown	5.3	7.1	Loam
Fairview 1	Gray	6.0	6.3	Sandy loam
Fairview 2	Gray	7.1	6.1	Sandy clay loam
Vegreville	Black	7.2	6.3	Clay loam
Melfort	Thin Black	11.3	6.6	Clay
Ellerslie	Black	12.2	6.2	Silty clay loam

Annual Forages-Suitability for NW Saskatchewan

S.M. Phelps, W. Vanin, L. Nielsen, and M. Nielsen

Summary

The purpose of the study was to evaluate the suitability of annual crops for forage production in NW Saskatchewan. Trials were conducted at Loon Lake and Scott, SK in 2003. The warm season (C4) cereals including millet, corn and sorghum were compared with the cool season (C3) cereals of barley, oats, and triticale in terms of forage yield. The crops were seeded near May 15th to simulate greenfeed production and June 10 to simulate swath grazing. Over all locations and dates, the corn out yielded all other crops. There was no significant difference between the C3 cereals and millets ($p < 0.05$) in terms of dry matter yields.

Background and Objectives

Livestock production in NW Saskatchewan has been increasing, therefore there is a need to increase forage production to meet the increasing demand for feed. Research in Canora and SE Saskatchewan indicates good yields with the warm season crops such as millet, sorghum and corn. Traditionally, cereals such as oats and barley, have made up the majority of greenfeed acres in the NW but there is more and more interest in the warm season cereals as an opportunity to increase dry matter and have quicker regrowth.

Study Description

Materials and Methods

In 2003 the Annual Forage study included sites at Scott, Loon Lake, and Lashburn Saskatchewan. Ten treatments were seeded in a randomized complete block design (RCBD) with four replicates (Table 1). SAS general linear model was used for statistical analysis. Lashburn site had seeding problems and data was not used in analysis.

The plots were seeded with a hoe drill seeding six rows with 9 inch spacing. Fertilizer was banded below the seed at a rate of 139 lbs of 36-14-0 blend at Scott, and 80 lbs of 40-25-0-5 blend at Loon Lake. All treatments received the same fertilizer except the corn intensive management. The corn intensive management treatment received the double rate of fertilizer. The corn intensive management was also seeded at double the rate and then every 2nd row was removed once emerged to simulate wide row spacing.

The sites were prepared for seeding by harrowing the wheat stubble then using preseed burn-off of Roundup at 0.5 l/acre. The first seed date occurred on May 16th at Scott and May 19th at Loon Lake. The second seeding date was June 11 for both Scott and Loon Lake. Incrop weed control was done by hand and Decis EC5 was used for grasshopper control at all locations.

Table 1. Treatments for annual forage trail 2003

Treatment	Cereal Type	Variety Use	Seeding Rate (lbs/acre)
AC Pinnacle Oats	C3	Feed Grain	114
CDC Bell Oats	C3	Forage	114
AC Ranger Barley	C3	Feed Grain	114
AC Rosser Barley	C3	Forage	114
AC Altima Triticale	C3	Spring	114
Crown Millet	C4	Forage	20
Golden German Foxtail Millet	C4	Swath grazing	20
Mega Green Sorghum	C4	Forage	20
Corn - Pioneer Hybrid 39T71	C4	Forage	15.6
Corn Intensive Management - 39T71	C4	Forage	32*

*double seeding rate then every second row was removed to simulate wide row spacings

Biomass samples were to be taken at appropriate stages as outlined in Table 1. At Scott four one meter rows per plot were taken for biomass analysis on the dates specified for each crop. On these dates some of the C4 crops were not at appropriate stages but it was advised that we take samples from them prior to Aug 15 to allow time for a second biomass sample prior to first fall frost. On these dates, the crown millet was heading but the golden German millet was not. The corn was not at 50% milk line but did have immature cobs. The second biomass sampling was done 14 days after the first. For the first seeding date at Loon Lake all treatments were harvested on 14th by taking 2 - ¼ metre square samples per plot. Second sampling of first seeding date and first sampling of second seeding date at Loon Lake occurred on August 26th. The samples taken were weighed (wet weight) and then dried at 55°C to obtain the dry weight. The dried samples were then ground and labeled for feed analysis. Plant heights and uniformity were recorded at biomass time.

Table 2. Stages for first biomass samples and dates samples taken at Scott.

Crop	Stage to take biomass samples	Scott - May seeding date	Scott - June seeding date
Oats	Milk dough	Aug 12	Aug 12
Barley	Soft dough	July 31	Aug 12
Triticale	Soft dough	Aug 12	Aug 12
Millet	2 weeks a/f heading	Aug 14	Aug 14
Corn	50% milk line	Aug 14	Aug 14

Results and Discussion

Data analysis was performed on combined data from four reps at Loon Lake and Scott. Results from uniformity and height are shown in table 3. The uniformity of the plots was rated on a scale of 1-10 (10 being the best). The sorghum and corn had the lowest score and were the least uniform. There was no difference in height between the warm and cool season grasses (excluding corn) but was some differences between individual varieties did exist. CDC Bell variety of oat was taller than AC Pinnacle. Crown millet was taller than golden German millet.

Table 3. Summary of Scott, Loon Lake and Lashburn.

Crop	variety	Uniformity	Height
		(1-10)	(cm)
Oat	AC Pinnacle	8.3	66.7
Oat	CDC Bell	8.3	73.0
Barley	Rosser	8.4	61.6
Barley	Ranger	8.6	61.9
Triticale	Ultima	8.6	79.7
Millet	Crown	7.8	78.4
Millet	Golden German	8.1	63.9
Sorghum	Mega green	5.4	72.0
Corn	LL 39T71	6.4	150.3
Corn IM	LL 39T71	7.0	146.9
LSD ($p<0.05$)		1.1	7.3
CV		10.7%	7.8%

In terms of biomass yields, the corn produced the highest biomass yields and the sorghum the lowest at both locations in 2003 (Table 4). There was no significant difference between the remaining C4 crops (millets) and the C3 cereals of oats, barley and triticale over all locations and within locations. There was no significant ($P<0.05$) effect of seeding date or location but there was an interaction of location by date and location by date by treatment.

Table 4. Dry matter yields from all locations and all seeding dates in 2003 (lbs/acre).

Crop	Variety	Loon Lake			Scott			All Location
		May	June	Average	May	June	Average	Average
Oat	AC Pinnacle	3.00	2.24	2.62 _c	2.66	3.17	2.91 _c	2.77 _b
Oat	CDC Bell	2.69	1.88	2.29 _c	2.49	2.99	2.74 _c	2.51 _b
Barley	Rosser	2.63	2.27	2.45 _c	2.14	2.17	2.16 _c	2.30 _b
Barley	Ranger	2.38	2.29	2.34 _c	2.66	2.94	2.80 _c	2.57 _b
Triticale	Ultima	2.51	2.60	2.55 _c	2.47	2.75	2.61 _c	2.58 _b
Millet	Crown	2.01	2.52	2.27 _c	3.15	2.83	2.99 _c	2.63 _b
Millet	Golden German	1.86	2.11	1.99 _c	2.68	2.38	2.53 _c	2.26 _b
Sorghum	Mega green	0.95	1.27	1.11 _d	1.38	0.84	1.11 _d	1.11 _c
Corn	LL 39T71	6.04	5.96	6.00 _a	4.35	5.67	5.01 _b	5.50 _a
Corn IM	LL 39T71	5.52	4.52	5.02 _b	4.96	7.44	6.20 _a	5.61 _a
LSD ($p<0.05$)		1.45	0.76	0.81	1.09	1.66	1.00	0.64
CV		33.8	18.9	28.3	26.1	34.5	32.2	30.51

Numbers with same letter following are not significantly different.

As all treatments were harvested on the same date varieties or crops with different maturities may not have been at the optimum stages for forage harvest. CDC Bell oats was consistently lower yielding than AC Pinnacle and this may be due to its later maturity. Within the C3 crops AC Pinnacle (oat) produced the highest average dry matter yield but the difference was not statistically significant.

Within the millets, the crown millet consistently out yielded the German golden millet. During the heat in August the golden German millet started to senesce while the crown millet remained green. The crown millet headed much earlier than the golden German millet at all locations.

The sorghum had poor emergence and not very uniform stands. Samples were taken where plants were and therefore may overestimate the dry matter yields for these crops. There were large areas within

the plots where no crop was present.

With the corn, emergence was slow but fairly even stands did emerge. There was no difference between the two corn treatments in terms of dry matter production over all locations and seeding dates. Corn was the highest producer of forage in 2003 as a result of the extra heat units received during July and August and the late fall frost (end of September). As corn is a crop that requires higher heat units and longer GDD than the other forages tested, it is not surprising that the corn outperformed the other forages in 2003.

Conclusions

Based on results obtained from two locations in 2003 it is apparent that under the growing conditions in 2003 the corn outperformed all other forages in terms of biomass production. Between the remaining treatments there was no significant difference between oat, barley, triticale and millet. Sorghum was the lowest yielding and the most variable forage cereal in 2003.

Indications for further development

It is apparent that the relative performance of annual forage species is highly influenced by environmental conditions. Continued analysis of these forages over a number of years and a number of conditions is warranted to truly evaluate their suitability for forage in NW Saskatchewan.

OPTIMIZING CROP YIELD THROUGH TIMELINESS OF WEED REMOVAL WITH LOW DRIFT SPRAYS 2003 Report

Eric N. Johnson and T.M. Wolf, Agriculture and Agri-Food Canada

Summary

Herbicide performance and crop yield was assessed in crops with differing competitive ability. Herbicide sprays were applied in a timely manner (i.e., early), and under less optimal timing (about 10 days later) using a range of spray qualities. Wild oat control was maintained with coarse spray qualities in competitive crop stands. Early weed removal was more important than spray quality in terms of crop yield.

Background and Objectives of Study

The time of weed removal is known to be of key importance in protecting high cereal, pulse, and oilseed yields in Saskatchewan. Implementing timely weed removal can be hampered by unfavourable weather conditions such as high winds, which cause significant delays in the application of herbicides. Low-drift sprays can be applied in a timely fashion under windier conditions, but there have been concerns with product effectiveness, particularly on the competitive grassy weeds. It is unknown whether the advantage of timely weed removal is offset by the disadvantage of reduced product efficacy.

The objective of this project is to develop practical information on the relative importance of timely weed removal vs. the use of coarser sprays. It is hypothesized that the lower efficacy with a coarse spray is more than compensated by the advantage of timelier removal that is facilitated by this technology.

Study Description

Materials and Methods

The experimental design of the study was a split-split plot with crop (barley, canola, and flax) being the main plot, nozzle type (untreated, fine, medium, and coarse droplet size) the sub-plot and timing of application (7 and 17 days after emergence) the sub-sub-plot.

Barley (cv. AC Metcalfe), Polish canola (cv. AC Sunbeam) and flax (cv. Vimy) were seeded on May 15, 2003. Crops were seeded on fallow using a hoe-press drill with a 22 cm row spacing. Wild oats, wild mustard and cow cockle were seeded at a uniform density between the crop rows at the same time as the crop was seeded.

Each crop was treated with a registered Group 1 graminicide tank-mixed with an appropriate broadleaf herbicide. The herbicides applied to each crop and the application rates are listed in Table 1.

Application was made with a tractor mounted sprayer calibrated to apply a carrier volume of 110 l ha⁻¹. Details on nozzle types are outlined in Table 1.

Table 1: Crops, herbicide, rates, nozzle type and timing of application used in study. Scott, 2002.

Crops	Nozzles	Volume Median Diameter	Timing
Herbicide/ Rate (g ai ha ⁻¹)			

Barley <i>Good competitor</i>	Achieve / 200	TeeJet XR8001	150	7 DAE ^z
	Buctril M / 560	Air Mix 11001	250	17 DAE
		TurboDrop XL 11001/TT11002	400	
Canola <i>Medium Competitor</i>	Select / 47	TeeJet XR8001	150	7 DAE
	Muster / 22	Air Mix 11001	250	17 DAE
		TurboDrop XL 11001/TT11002	400	
Flax <i>Poor competitor</i>	Select / 47	TeeJet XR8001	150	7 DAE
	Buctril M / 560	Air Mix 11001	250	17 DAE
		TurboDrop XL 11001/TT11002	400	

^zDAE = Days after emergence

Data collected included crop density and fresh weight, weed density and fresh weight (by species), and crop yield.

Results and Discussion

The barley and canola established well with mean plant densities of 187 and 121 plants m⁻², respectively. The flax did not as establish quite as well as the mean density was 72 plants m⁻², which is well below the desired plant population of 300 to 400 plants m⁻².

Effect of crop, nozzle type and application timing on weed control

Results on wild oat fresh weight are presented in Figure 1 and Table 2. There was a significant crop by nozzle type interaction for wild oat control (Figure 1). In the more competitive stands of barley and canola, each nozzle type caused similar reductions in wild oat biomass. However, the coarse spray quality produced by the Turbodrop XL nozzle was not as efficacious as the other nozzles in the non-competitive flax stand. Therefore, the reduction in efficacy observed with coarse sprays may be less of an issue in competitive crop stands. Early spraying resulted in a lower wild oat fresh weight, which was consistent across crop and nozzle type (Table 2).

The results for wild mustard control were similar to other broadleaf weed species; therefore, the discussion will be limited to wild mustard since it was the dominant broadleaf weed species. Crop had a significant effect on wild mustard fresh weight with values of 21, 207, and 92 g m⁻² for barley, canola, and flax, respectively. The higher level of wild mustard in the canola is likely due to the lower efficacy of the Muster herbicide. All nozzles resulted in similar reductions in wild mustard biomass (Table 3). Unlike the wild oats, there was no timing effect indicating that control of wild mustard was similar for both early and late application.

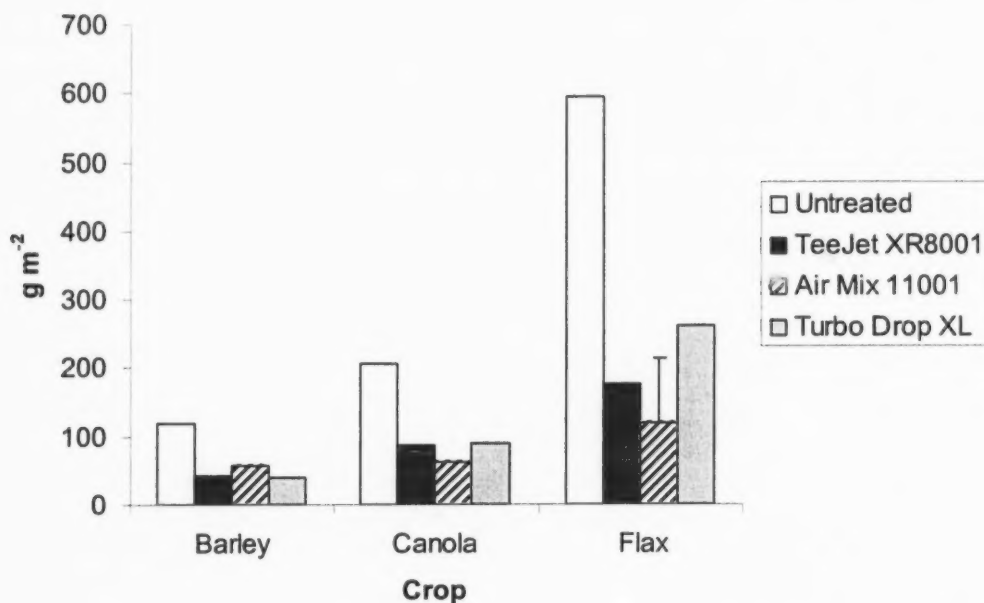


Figure 1: Interaction of crop and nozzle type on wild oat fresh weight. Bar represents the $LSD_{0.05}$ for the crop X nozzle type interaction. Scott, 2003.

Table 2: Effect of timing of herbicide application on wild oat fresh weight ($g\ m^{-2}$). Means of 3 crops, and 4 nozzle types. Scott, 2003

Application Timing	Wild oat fresh weight ($g\ m^{-2}$)
7 DAE	127.6
17 DAE	180.5
$LSD_{0.05}$	51.4

Table 3: Effect of nozzle type on wild mustard ($g\ m^{-2}$). Means of 3 crops, and 2 application timings. Scott, 2003

Nozzle	Wild mustard fresh weight ($g\ m^{-2}$)
Untreated	210.3
Tee Jet XR 8001	69.3
AirMix 11001	72.8
Turbodrop XL 11001	73.8
$LSD_{0.05}$	41.0

Effect of crop, nozzle type and application timing on crop yield

For crop yield, there was a significant crop by nozzle type interaction but it appears to be due to differences in crop response to herbicide application. All nozzle types resulted in a yield increase in the barley and flax; however, there was not a detectable yield increase with any of the nozzles in canola (Figure 2). This is likely due to the poorer control of wild mustard in canola compared to the barley and flax.

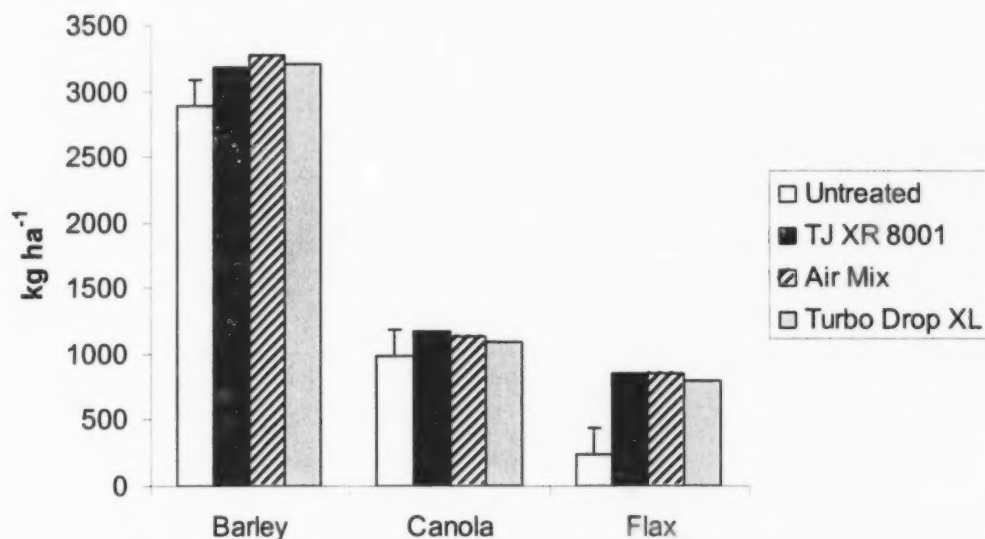


Figure 2: Interaction of nozzle type with yield of barley, canola, and flax (kg ha⁻¹). Bar represents the LSD_{0.05} for the crop X nozzle type interaction. Scott. 2003.

The other significant interaction for crop yield was a nozzle by timing interaction (Figure 3). Crop yields declined with the medium and coarse spray qualities when applied late, but yields were not significantly different from the fine spray quality when applied early. Therefore, crop yields can be maintained with coarse sprays provided that they are applied in a timely manner.

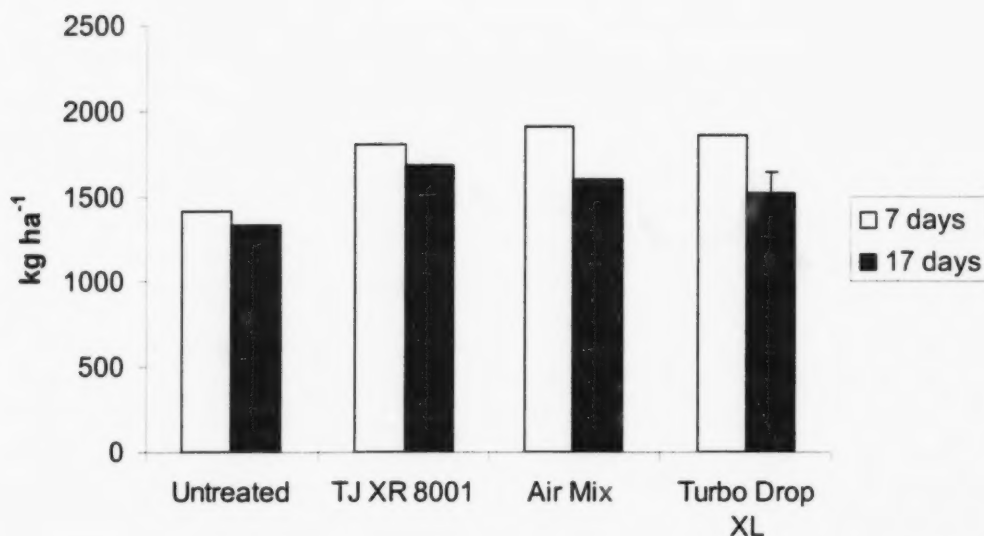


Figure 3: Interaction of nozzle type with timing of herbicide application on crop yield (mean of barley, canola, and flax). Bar represents the $LSD_{0.05}$ for the nozzle type X timing interaction. Scott. 2003.

Conclusions

The first year of this study indicates that crop yield will not be compromised by a coarse spray quality provided that a competitive crop stand is present and application timing is not delayed. Timely application is more likely to occur with low drift (coarse spray quality) nozzles since herbicides can be applied in a wider range of environmental conditions.

Indication for further development

The experiment will be repeated in the future. The data suggests that there is opportunity to explore interactions of low-drift nozzle technology with other cultural and integrated weed management strategies. Evaluation of reduced rates combined with nozzle technology and integrated practices appear to be the next logical step.

Brassica species for forages

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Summary

The purpose of this study was to evaluate the growth of turnip varieties in relation to canola in NW Saskatchewan to determine optimum time for grazing and regrowth. Trials were conducted at Scott, Loon Lake, and Lashburn in 2003. The conventional turnip variety (Marko) was compared to a hybrid variety (Typhon). The hybrid variety is based on a cross between Chinese cabbage and turnip. Also included was a canola hybrid LL 2663. Establishment of the crops, forage yields in terms of dry matter production, uniformity, and regrowth after cutting were evaluated for each variety. Dry matter accumulation was very similar between the brassica species when total biomass was analyzed. Canola (LL2663) produced the greatest total biomass at 4177 kg/ha, followed by the turnips at 3920 kg/ha for Marko and 3270 kg/ha for Typhon. Although Marko produced greater total biomass than Typhon, Typhon produced more above ground material. Forty percent of the total biomass produced by Marko was from below ground portions. For canola (LL 2663) and Typhon turnip the below ground portion made up 15 to 20% of the total biomass at the time of maximum biomass production. For turnips the optimum time for grazing is suggested to be at maximum production of above ground biomass and as early as possible to allow maximum regrowth. After this time there is little gain in above ground biomass and regrowth period would be shortened. The point at which this occurred in 2003 at Scott was between 500 and 600 GDD which corresponded to between July 14 and 21st (Figure 1). However, previous recommendations for grazing turnips were 60 days after seeding which corresponded to July 28. Above ground material harvested at this time from Lashburn, Loon Lake and Scott averaged 3497 kg/ha for canola, 2904 kg/ha for Typhon turnips and 2350 kg/ha for Marko turnips. There was no regrowth of these plots as insect infestations and dry conditions were prohibitive.

Background and objectives

Brassica species have been long known for their use as forage crops in much of the world. Turnips, rutabagas, rape, kale and Swedes are examples of commonly used forage brassicas. The short-season root brassicas such as rutabagas and turnips provide roots, stem and leaf growth for grazing and have good tolerance to frost. Top growth generally will survive temperatures between 15-20 degrees F, while bulbs will be about 5 degrees hardier. The protein levels from production in the United States range from 17-24% for tops and 12-15% for roots. In 2002 turnips were grown in Scott, SK and protein levels were 20% for tops and 17% for bottoms. High digestibility with total digestible nutrients (TDN) of 75-90% and relative feed value (RFV) of 350-400% also make these crops appealing for livestock producers. Nutritive components coupled with adaptability of other brassica species, such as canola and mustard, suggest that turnip species as a forage crop may have a fit in the forage and livestock industry in Western Canada. The objective of this research was to establish a growth curve for turnips to identify optimum time for grazing and to obtain yields of forage produced.

Study Description

Materials and Methods

In 2003 the study was conducted at the three locations of Scott, Loon Lake, and Lashburn. Three forage crops outlined in Table 1 were seeded in a randomized complete block design (RCBD) with four replicates.

Table. 1 Treatments for Brassica for forage trial 2003

Treatment #	Treatment crop	Variety	Seeding rate lbs/acre
1	Turnip	Marko-conventional	5
2	Turnip	Typhon-Hybrid	5
3	Canola	LL 2663-Hybrid	6

Prior to seeding weed control strategies included surface applications of Edge at 7 kg/ha with no incorporation followed by preseed burn off with Roundup. The plots were seeded with a modified hoe drill set up to seed six rows with 9 inch spacing. Fertilizer was banded below the seed at a rate of 138 lbs per acre of 50-10-0-5 blend. Protection against flea beetles included application of Counter 5G seed placed followed by Decis EC5 application as needed. Hand weeding was done in plot to control weeds.

The plots were seeded at Scott on May 27th, Loon Lake on May 28th, and Lashburn on May 29th. The plots were seeded 12 rows wide. The first 6 rows were used for weekly measurements, starting 3 weeks after seeding, of above and below ground growth using $\frac{1}{4}$ m². The other six rows were mowed at 60 days after seeding to evaluate regrowth. At Loon Lake and Lashburn there was only 60 day biomass samples taken and there was very little regrowth due to grasshoppers, flea beetles and lack of moisture.

At Scott biomass was measured weekly starting at 2-3 leaf stage on June 16th. Biomass consisted of $\frac{1}{4}$ metre square samples of above and below ground material. Plant material was weighed then dried at 55 degrees C to obtain dry weights.

Results & Discussion

The growth curves obtained from Scott are shown in Figure 1 and show that turnip growth curve resembles that of canola in terms of total biomass produced. Growth is logarithmic up to 500 GDD where growth starts to slow and reach a plateau at 600 GDD for Typhon turnips and at 700 GDD for Marko turnip and LL 2663 canola. The data points near 700 GDD for Marko turnip and LL 2663 canola are much higher than for the Typhon turnip. The canola shows a leveling of biomass production by the data points between 500 and 600 GDD and this could be the result of a loss of some lower leaves during podding stages. The increase in biomass production dramatically from the 600 GDD to 700 GDD could be a result of pod formation and fill followed by another leaf loss and then a leveling off of biomass production as seeds mature. This is similar to previous findings for canola by Stu Brandt at AAFC, Scott (personal communication).

With the turnips the total biomass production reached a maximum and then started to decline. This loss is due to drop of older leaves. In August, the higher than normal heat units with the lack of moisture caused the turnips and the canola to undergo severe stress. The canola matured rapidly while the turnips lost leaves. An additional factor to the reduction of biomass in August is the high grasshopper and flea beetle populations. With these insects present in large numbers the decline in biomass may have been increased.

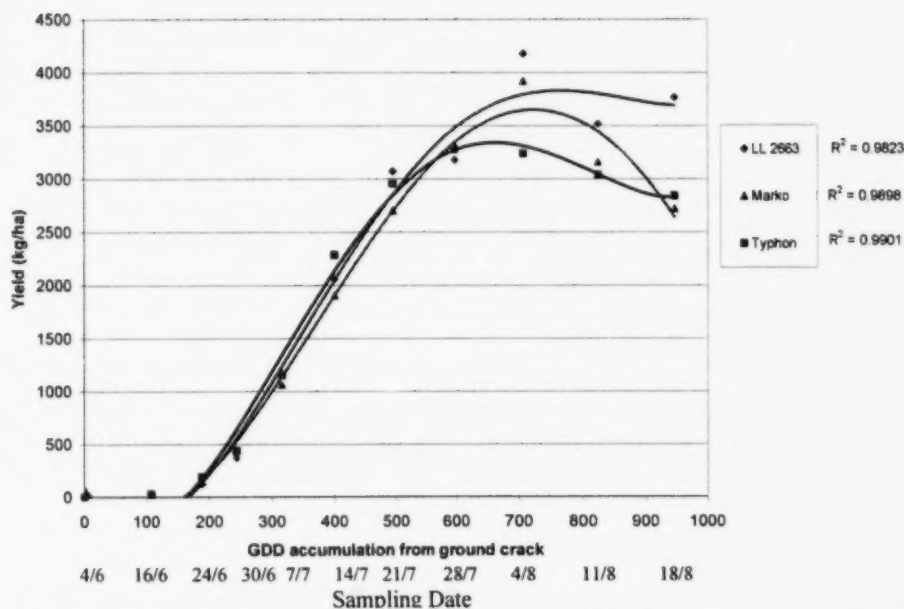


Figure 1. Growth curve of two turnip varieties (Marko and Typhon) and one canola variety (LL 2663) based on growing degree day (GDD) accumulation starting at ground crack on June 4, 2003. Sample dates are indicated at the bottom of the figure. Fourth order polynomial was used to show the curves.

Further examination of biomass accumulation into above and below ground portions of the plant reveals a difference between the two turnip varieties (figure 2). The Typhon turnip which is the Chinese cabbage and turnip hybrid produced more above ground material and very little below ground material which is similar to canola. With Marko turnips the above ground biomass accumulation curve is similar to Typhon in shape but the maximum level of accumulation is 500 kg/ha less than the Typhon variety. The Marko variety produces a bulb while the Typhon variety does not. The accumulation of biomass in the bulb starts at about the 400 GDD mark. Accumulation continues with maximization between 700 and 800 GDD after which there is a gradual decline in biomass. Maximization of below ground biomass occurs after the maximization of above ground biomass.

At maximum above ground biomass points canola produced at least 750 kg/ha more material than Typhon turnip and 1340 kg/ha more than Marko turnip. However, the above ground material in canola consists of stems, pods and leaves whereas the above ground material of turnips contains only leaves which are easier to digest and contain better nutritive content compared to stem and pod material.

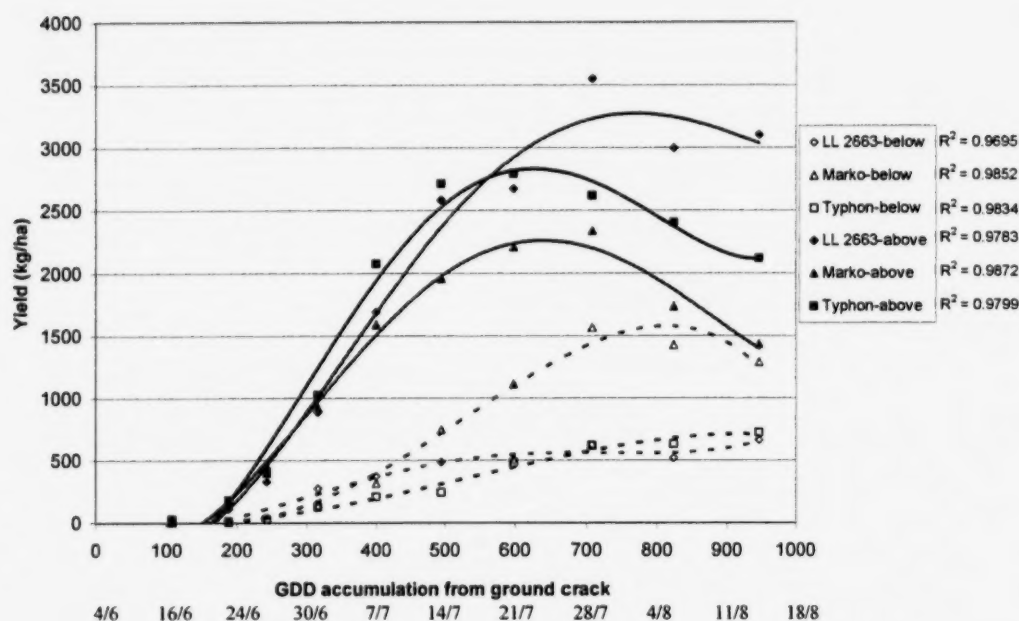


Figure 2. Above and below ground dry matter in kg per hectare. Forth order polynomial trendlines were used to depict the growth curves. Sampling dates are indicated below the figure.

By the end of the sampling period, at 947 GDD after ground crack, the Marko variety of turnip has almost equal biomass in the above and below ground portions. With canola, the proportion of biomass below ground is consistent throughout the growing season and goes from 10 to 18% as the season progresses with the exception of 24% at 316 GDD. All species had higher numbers for below ground biomass on 316 GDD sample time. This could be the result of sampling error where the dividing line between above and below ground biomass may not have been consistent from the other sample times and more biomass went into the below ground portion than should have.

The turnip variety Typhon increased below ground biomass from 7% to 25% of the total biomass over the 947 GDD period. This shows that even though Typhon does not produce the typical turnip bulb it does increase the amount of dry matter in the below ground portion of the plant. As turnips are biennial plants it is not surprising that they increase the below ground biomass portion prior to senescence.

Along with growth curve analysis the above ground material from the second half of the plots were cut to simulate grazing. Biomass was taken and results are in Table 2 and show that canola produced the greatest amount of above ground biomass followed by the Typhon variety of turnips. The Marko variety of turnip produced the lowest amount of above ground biomass. The results are similar to those from 2002 where above ground biomass was 3559 kg/ha for Loon Lake and 2778 kg/ha for Scott with another variety of turnip called Civastro. Regrowth on these mowed plots was very poor as the plots were mowed too short, soil conditions were dry and there was high flea beetle and grasshopper pressure.

Table 2. Above ground biomass from all three locations taken 60 days after seeding.

Lashburn	Loon Lake	Scott	Average
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Crop - Variety	Dry Matter (kg/ha)				Tons/acre
Canola - var. LL 2663	3159 _a	4721 _a	2526 _a	3497 _a	1.56
Turnip - var. Marko	2586 _a	3113 _b	1409 _c	2350 _c	1.05
Turnip - var. Typhon	2853 _a	3711 _b	2136 _b	2904 _b	1.30
Lsd ($p < 0.05$)	880	999	281	375.5	
CV	13.5	15.0	8.0	14.2	

Means with same letters are not significantly different.

Conclusions

Turnips are an appealing alternative for grazing in terms of the amount of forage produced, the digestibility, protein and feed values. The growth curve is very similar to that of canola which is adapted well to Western Canada. Yield potential is still unknown as under drought conditions averages were 2350 to 2904 kg/ha for top growth but we have no information for under better moisture conditions. From the growth curve analysis it was found that Marko variety of turnip had another 1113 kg/ha of biomass in the tuber. Adding this amount to the above ground portion brings up the total biomass to 3363 kg/ha which is very close to that of canola (3497 kg/ha). From the growth curve it was found that between 500 and 600 GDD could be the appropriate time for the first graze. Prior to this stage would reduce yields dramatically and after this stage there would be no gains in dry matter and there would be less time for regrowth. Unfortunately in 2003 there was very little regrowth on the plots as a result of flea beetles, grasshoppers and the very dry conditions.

Indication for Further Development

Further research on turnips is needed under better moisture conditions. A repeat of this experiment over number of locations and environmental conditions is warranted to better evaluate growth and suitability in Western Canada. Also, research is needed on pest control, optimizing cutting times to maximize total biomass production and regrowth potential, and intercropping possibilities.

